SCUOLA DI SCIENZE AGRARIE, FORESTALI, ALIMENTARI ED AMBIENTALI

COURSE: Automation and process control in the agro-food industry			
ACADEMIC YEAR: 2019/2020			
TYPE OF EDUCATIONAL ACTIVITY: Affine			
TEACHER: Giuseppe Altieri			
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Language: Italian			
ECTS: 6 (5 lessons and 1 tutorials/practice)	**n. of hours**: 56 (40h lesson and 16h tutorials/practice)	**Campus**: Potenza **School**: SAFE **Program**: Second Cycle in Food Technology	**Semester**: II

EDUCATIONAL GOALS AND EXPECTED LEARNING OUTCOMES

The course covers topics related to automation, control, management and process optimization of machines and plants for food processing, with detailed reference to both sensors and actuators currently used in the agro-food processing plants, especially in dairy industry, wineries , olive oil extraction plants and packinghouse, with emphasis on spectrophotometric sensors. The goal of the course is to provide students with the knowledge of the basic elements involved in the implementation of unit operations in agro-industrial processes automation.

- ***Knowledge and understanding***: knowledge and understanding of problems related to different measurement methodologies of most common plant parameters with related measurement error estimate; to use of actuators and spectrophotometric sensors and standard sensors used for the detection of agro-industrial process parameters; to most common applications of control systems, automation, management and process optimization in the food industries; to most used software in industrial data management applications, process control and automation; to basics procedures for sizing of control systems, automation, management and optimization of machinery/equipment for the agro-industrial field; to advanced technologies for monitoring, management and optimization of production processes in the food and agricultural industries.
- ***Applying knowledge and understanding***: ability to select, size and integrate sensors/actuators and control systems with reference to the different applications in the food industry; ability to know how and be able to discuss the most common applications of sensor-actuator-control systems related to agro-food industries; ability to perform simple calculations to properly evaluate the choice/design of a control and management system of a specific agro-food process.
- ***Making judgements*:** ability to know how to choose and apply, giving reasons, a specific sensor-actuator-control system to a specific production process related to agro-food industries; ability to specify the mode of operation and optimal management of a process with reference to the specific food production.
- ***Communication skills***: ability to communicate the impact and cost of employing a certain automation and/or control system for a given production process, even with reference to both process energy saving and quality of food product.
- ***Learning skills*:** ability on how to use the main reference textbooks about technical and scientific literature to take advantage of the innovation developed at the scientific level in order to constantly advance scientific and cultural personal skills.

PRE-REQUIREMENTS

The following skills are needed:

- basic concepts of mechanics, kinematics and dynamics;
- basic concepts of thermodynamics and fluid mechanics;
- classification and recognition of the machines/systems of agro-food industries;
- building elements and operation of machines/systems of agro-food industries.

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SYLLABUS

The course is composed of 7 teaching blocks (TB) related to plant parameters measurement, hardware devices for data acquisition, sensors functioning principles, spectrophotometric sensors, software for data management and analysis, process control/automation and advanced process control principles.

TB1 - Plant parameters measurement (4h theoretical lessons)

- Physical variables measurement and related measurement error.
- Measurement data processing.
- Electrology basic principles.
- Overview of DC and AC electric circuits.
- Measurement of electrical quantities and measuring bridges, effect of noise on the electrical measurement.
- Sensors and transducers, physical variables and signals.
- Static and dynamic characteristic of a transducer.
- Characterization of the measurable physical variables using sensors: acceleration, temperature, mass flow, volume, density, pressure, conductivity, pH, gas concentration, relative humidity, speed of rotating shafts, normal stress, torque, viscosity, consistency, level.

TB2 - Data acquisition principles and hardware devices (6h theoretical lessons +2h classroom tutorials)

- Data acquisition: Analog to Digital (A/D) conversion.
- Sample and Hold (S/H).
- Sampling and quantization.
- Quantization error and aliasing error.
- Data acquisition boards.
- Multi-channels data acquisition boards and channel synchronization.
- Data acquisition management and analysis software: LabView.
- Plant applications (numerical and detailed cases study).

TB3 - Sensors for the measurement of process plant parameters and their current use (8h theoretical lessons +2h classroom tutorials)

- Classification of sensors based on the measured physical variable, nature of the output signal, output signal type, sensors with logic, analog and digital output.
- Resistive, inductive, capacitive, piezoelectric, thermoelectric, photovoltaic, Hall effect sensors.
- Position, strain, force, pressure, acceleration sensors.
- Temperature sensors: thermocouples, RTDs, thermistors, infrared temperature sensors and with direct digital conversion.
- Proximity sensors, REED contact, Hall effect, inductive, capacitive, ultrasonic, optoelectronic.
- Flow sensors: volumetric, mass, Coriolis, rotating, magnetic, Doppler, ultrasonic.
- Resistive hygrometers, resistive gas sensors, vibrating level sensors, radar, ultrasonic and optical.
- pH, RedOx potential, conductivity, turbidity sensors, electrode configurations for the food industry.
- Dissolved Oxygen, free Chlorine sensor.
- Torque, speed of rotating shafts, humidity sensors, gas concentrations, PID (Photo Ionization Detector), viscosity and consistency sensors.
- Biochemical sensors.
- Plant applications (numerical and detailed cases study).

TB4 - Spectrophotometric sensors and their current use (4h theoretical lessons +2h classroom tutorials)

- Methods of data acquisition and collection using UV-VIS-NIR spectrophotometers.
- Techniques of multiple linear correlation applied to UV-VIS-NIR spectra arising from spectrophotometric sensors.
- Data analysis software: Matlab with “Statistics and Machine Learning Toolbox”.
- Detailed case study applications using real data.

TB5 - Signal transmission and process control (8h theoretical lessons +4h classroom tutorials)

- Industrial standards of signals transmission: analog methods, current loop, digital methods, field buses,

digital data transmission protocols.
- Interconnection of sensors/actuators distributed on the plant, the field concept.
- Distributed control systems (DCS) and supervisory control and data acquisition (SCADA) systems.
- Feedback control systems: operating schematics, pseudo-code, characteristics.
- Causes leading to feedback control system instability.
- Stabilization by PID and its empirical tuning.
- Feedback control system simulation software: Matlab with Simulink.
- Feedback control system characterization and optimization by simulation.
- The variable frequency driver (VFD) applied to the management of tree-phases asynchronous electric motor.
- Some applications in food industry.
- Plant applications (numerical and detailed cases study).

TB6 - Process automation (4h theoretical lessons +2h classroom tutorials)
- Automation and programming.
- Wired logic and programmed logic.
- Basic principles of finite states automata.
- Process automation management.
- The programmable logic controller (PLC) and its use in process automation.
- Food industry applications (numerical and detailed cases study).

TB7 - Advanced control systems (6h theoretical lessons +4h classroom tutorials)
- Fuzzy logic.
- Neural networks logic.
- Neuro-Fuzzy logic.
- Characterization and optimization by simulation.
- Food industry applications (numerical and detailed cases study).

TEACHING METHODS

The course is based on 7 teaching blocks and it provides 40 hours of theoretical lessons and 16 hours of guided classroom tutorials. The guided classroom tutorials are based on numerical and detailed cases study related to food industry applications and plant applications using real data.

EVALUATION METHODS

The aim of examination is to verify the student achieved skills as previously listed.
The examination consists in an oral presentation of a work of deepening study about a topic related to the course, from this starting point the oral examination will continue on other topics treated during the course aiming to evaluate student skills.

TEXTBOOKS AND ON-LINE EDUCATIONAL MATERIAL

The course material is constituted of selected material from reference textbooks and handouts in electronic format stored on a document cloud which will made accessible to the students.

The recommended textbooks, to further deepen the topics covered in the course, are the following:

- Bimbenet J.J., Dumoulin E., Trystram G., 1994, Automatic control of food and biological processes, Elsevier Science B.V., Amsterdam, The Netherlands;
- Sharma S.K., Mulvaney S.J., Rizvi S.S.H., 2000, Food process engineering: theory and laboratory experiments, Wiley-Interscience, John Wiley & Sons, Inc., New York, USA;
- Singh R.P., Heldman D.R., 2001, Introduction to food engineering, Academic Press, San Diego, California, USA;
- Singh R.P., Heldman D.R., 2015, Principi di Tecnologia Alimentare, Zanichelli, Casa Editrice Ambrosiana;
- Valentas K.J., Rotstein E., Singh R.P., 1997, Handbook of Food Engineering Practice, CRC Press LLC, 2000 Corporate Blvd., N.W., Boca Raton, FL, USA.

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INTERACTION WITH STUDENTS

At beginning of the course the lecturer will explain to students the pre-requirements needed, the educational goals, the expected learning outcomes, the course syllabus (structure/organization), the evaluation methods and the reference textbooks. Subsequently the students who will attend assiduously the course are asked for their name, surname and E-mail. After each lecture, related documents in electronic format will be available on a document cloud accessible to the students.

The lecturer will be available to receive students Tuesday (15.00-17.00) and Wednesday (15.00-17.00) and/or even in other days preferably after an E-mail contact.

>>> building **3A-SUD**, floor **4**, room **367** (link GEOLOC) & (link MAPLOC)

EXAMINATION SESSIONS (FORECAST)[1]

11	set, 2019
9	ott, 2019
6	nov, 2019
11	dic, 2019
15	gen, 2020
5	feb, 2020
4	mar, 2020
8	apr, 2020
6	mag, 2020
10	giu, 2020
8	lug, 2020

EVALUATION BOARD

Giuseppe Altieri (President), Giovanni Carlo Di Renzo (Member), Francesco Genovese (Member).

SEMINARS BY EXTERNAL EXPERTS YES □ NO ●

FURTHER INFORMATIONS

Nothing.

[1] Subject to possible changes: check the web site of the Teacher or the School for updates.